

Feathered Dinosaurs

Paleontologists have long depended on fossils of bones to reconstruct how species looked. They recognized that dinosaur skeletons were extremely similar to bird skeletons, but did not yet fully understand their relationship. During the past few years, many fossils have been found of feathered dinosaurs. This is remarkable in itself because compared to bones, feathers are very slim and fragile resulting in very few fossils.

This poster shows the most important feathered dinosaurs. Species definitely known to have had feathers, as proved by fossils, are indicated by the feather shown at right. Scientists believe that all other members of the family also had feathers and several other important family members are shown, even though no proof of feathers has yet been found.

Compsognathidae



Compsognathus longipes
Means: "Elegant Jaw" Pronounced: Komp-so-Nath-us
Age: Jurassic - 150 MYA. Place: Germany, France
Length: 3 feet / m. Weight: 6 lbs / 3 k
Compsognathus is considered an important link in the study of bird evolution. The original fossil of this dinosaur was found in the same place as Archaeopteryx, the early feathered reptile and "Compy" shares a number of characteristics with it. The discovery of Sinosauroptryx prima has led some authorities to speculate that "Compy" may have had down-like covering of small plumulaceous feathers of up to 14 mm (about 1/2 inch) long, that presumably served as thermal insulation.

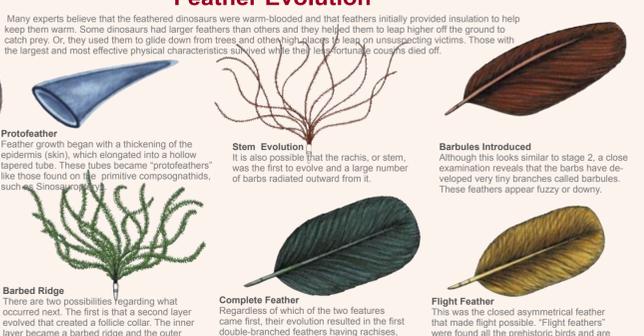
Compsognathus Forelimb
It had short arms with two clawed fingers on each hand.

Sinosauroptryx Forelimbs
An adapted scapula, or shoulder blade, permitted a greater range of movement in the forelimb. This resulted in arms. Although many animals, such as horses and dogs, have this bone, their forelimbs remained legs.



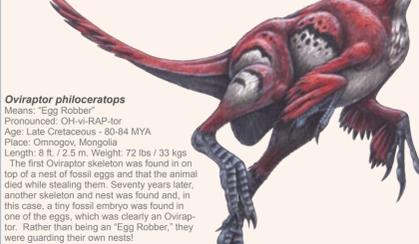
Sinosauroptryx prima
Means: "Chinese Lizard with Feathers"
Pronounced: SIE-n-o-saw-OP-ter-iks
Age: Early Cretaceous - 125 MYA. Place: Liaoning, China
Length: 4 ft. / 1.3 m. Weight: 5.12 lbs. / 2.5 kgs
The 1996 discovery of Sinosauroptryx prima shocked the paleontology world. The fossils show hair-like "protofeathers." These are long, filamentous structures that seem to have formed a hair-like covering over most of the body. This is the most primitive coelurosaur ever found with feathers. This creature was about the size of a large chicken.

Feather Evolution



Oviraptorosauera

Oviraptorosaurs first appear in the fossil record in the early Cretaceous. We know they had bird-like feathers because fossil remains of an early member of the group, Caudipteryx, show this animal had advanced feathers on the arms and tail. These are just like the feathers of a bird, except that they lack the asymmetry that defines modern flight feathers. They correspond well to Stage 4 of the "evo-devo" model of feather evolution. There is evidence that the entire body may have had a down-like covering of small plumulaceous feathers of up to 14 mm (about 1/2 inch) long, that presumably served as thermal insulation.



Oviraptor philoceratops
Means: "Egg Robber"
Pronounced: OH-iv-RAP-for
Age: Late Cretaceous - 69-84 MYA
Place: Omnogov, Mongolia
Length: 8 ft. / 2.5 m. Weight: 72 lbs / 33 kgs
The first Oviraptor skeleton was found in an egg of a nest of fossil eggs and that the animal died while stealing them. Seventy years later, another skeleton and nest was found and, in this case, a tiny fossil embryo was found in one of the eggs, which was clearly an Oviraptor. Rather than being an "Egg Robber," they were guarding their own nest!



Nomingia gobiensis
Means: "Nomingia" (a part of the Gobi Desert)
Pronounced: no-MING-ee-uh
Age: Late Cretaceous - 68 MYA
Length: 3 feet / 1 m. Weight: Unknown
This little dinosaur is a good example of the term "missing link." It was developing features of modern birds. The most important was a short tail that ended in a pygostyle. This is the type of bone that attaches tail feathers to bodies of birds. It permits them to steer while flying. Nomingia was just about ready to fly!

Tyrannosauroidae

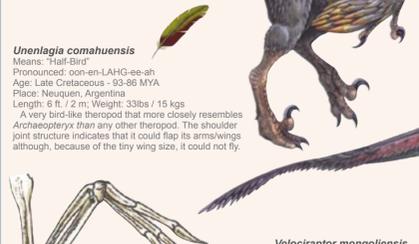
The discovery of feathers on so many closely related species led many scientists to speculate that Tyrannosaurus also had feathers. Their prediction proved to be correct when *Dilong paradoxus* was discovered in 2004. Tyrannosaurus were the largest and most powerful of the meat-eating dinosaurs and have long been regarded as the fiercest animals that ever lived. Wouldn't it be a big surprise to everyone if Tyrannosaurus rex turned out to be a really big chicken? But that is probably not the case, as T. rex's powerful jaws and sharp teeth establish that its eating habits were considerably different from a bird. However, baby tyrannosaurs may have had feathers to provide insulation.



Dilong paradoxus
Means: "Emperor Dragon Paradox"
Pronounced: Dee-long
Age: Early Cretaceous-125 MYA
Place: Liaoning, China
This tiny, earlier ancestor of Tyrannosaurus rex was unique in that it had a partial coat of hair-like feathers, known as protofeathers. Fossils of four specimens have been found. One had feathers. Since Dilong predates T. rex by many millions of years, scientists now believe that all of the tyrannosaurs could have had feathers, at least when young.

Dromaeosauridae

The dromaeosaurids were one of the important groups of Cretaceous meat-eating dinosaurs. Very closely related to birds, these small to large sized dinosaurs are distinguished by the enormous killing claw on the enlarged second toe, which was held off the ground when the animal walked or ran and which was used to bring down large prey. They were popularized as the "raptors" of the Jurassic Park movies, where they are incorrectly shown as scaly and featherless. Dromaeosaurids in life were very bird-like, very like their near relatives the archaeopterygid birds. In all likelihood, they were warm-blooded with a bird-like metabolism.



Unenlagia comahuensis
Means: "Hall-Bird"
Pronounced: oon-eh-LAHG-ee-ah
Age: Late Cretaceous - 93-86 MYA
Place: Neuquen, Argentina
Length: 6 ft. / 2 m. Weight: 33lbs / 15 kgs
A very bird-like theropod that more closely resembles Archaeopteryx than any other theropod. The shoulder joint structure indicates that it could flap its arms/wings, although, because of the tiny wing size, it could not fly.

Unenlagia Forelimb
The scapula evolved into a different shape. This allowed this ostrich-sized animal to have greater up-and-down mobility in its arms. It now appears that other dromaeosaurids were able to move their arms this way too.



Velociraptor mongoliensis
Names Means: "Swift Robber"
Pronounced: vel-Os-ih-RAP-for
Age: Late Cretaceous - 67 MYA
Place: Gobi Desert, Mongolia
Length: 6 ft. / 3 m. Weight: 60 lbs. / 25 kg
The movie "Jurassic Park" made Velociraptor famous. The real Velociraptor is much smaller than in the film and it has a longer, thinner snout. It did have a large brain, but was not smart enough to open doors. Still, pound for pound, Velociraptor was a very effective killing machine! Its most famous characteristic is the "Killing Claw".



Protarchaeopteryx robusta
Means: "First Ancient Wing"
Pronounced: Pro-ter-key-OP-ter-ix
Age: Early Cretaceous - 135 MYA
Place: Liaoning Province, China
Length: 3 ft. / 1 m. Weight: 10 lbs. / 4 kg
This animal is considered to be more primitive than Archaeopteryx and it is more like the non-avian theropods. Protarchaeopteryx specimens were found with feather impressions. The best preserved of the newest specimens definitively shows feathers attached to the front leg and tail. Unlike Archaeopteryx, however, Protarchaeopteryx's feathers are symmetrical, indicating that Protarchaeopteryx may not have been able to fly. Anatomical it's best advanced than Archaeopteryx, but lived 15 million years later.

Archaeopteryx Forelimb
Long considered the first bird, it had asymmetrical feathers and fully developed wings that it could lift high above its head. It lacked the strong chest muscles and short tail essential for prolonged controlled flight. Flying was limited to short hops.

Therizinosauridae

Therizinosaurids were a bizarre group of giant feathered dinosaurs related to oviraptors. The 1999 discovery of the primitive *Beipiaosaurus* in Liaoning, China, brought a surprise. It was covered with protofeathers. These hair-like filaments seem to have been hollow. The fibers have branched at the ends and seem to correspond to either Stage 1 or Stage 2 of the "evo-devo" model of feather evolution. Large patches of filaments have been preserved on both the forearms and the legs. By implication, all therizinosaurids had feathers.



Caudipteryx zoui
Means: "Tail Feather"
Pronounced: kaw-DIP-ter-iks
Age: Early Cretaceous - 125 MYA; Place: Liaoning, China
Length: 28-36 in. / 70 - 90 cm. Weight: 25 lbs. / 7 kgs
Fossil remains indicate animal had advanced feathers. There is a fan of paired feathers on either side of the end of the tail. Long feathers were on its arms. There is evidence that its entire body may have had a down-like covering, as the hips and the base of the tail of the original specimen are covered by small plumulaceous feathers.



Incisivosaurus gauthieri
Means: "Innocent Lizard"
Pronounced: in-siz-EE-voh-SORE-ee-us
Age: Cretaceous Period - 120 MYA
Length: 3 ft / 1 m. Weight: 9 lbs. / 4 kg
While most other Oviraptorids had no teeth, Incisivosaurus had a mouth full of them, including enormous gnawing incisors, r. similar to the "buckteeth" found in moose and beavers. They have given rise to it being called a "cross between Bugs Bunny and the Road Runner." Incisivosaurus was obviously no carnivore.

Pygostyle
Nomingia gobiensis is unique in that the last five vertebrae on its tail are fused together, creating what is called a "pygostyle." Pygostyles are used to anchor the tail feathers. It lets them steer while flying. The presence of this bone in the oviraptorosaurs establishes that they tail feathers too.

Avimimus portentosus

Avimimus looked so much like a bird that its name literally means that it imitates a bird. It looks like a large reptilian roadrunner. Avimimus had a long, lean neck topped by a short skull that was equipped with a toothless beak and a relatively large braincase. It had long, slender back legs built for fast running. But its front limbs had not yet evolved into wings. They were lightly built and equipped with sharp, curved claws. Avimimus had the ability to fold its whole arm against its body, much like the wings of a bird. Unlike a bird however, Avimimus had a long bony tail. The deposits in which the fossils were found were to coarse to preserve impressions of feathers.



Sinornithoides youngi
Means: "Chinese bird form"
Pronounced: sy-NOR-nith-oid-eez
Age: Middle Cretaceous - 110 MYA
Place: Mongolia, China
Length: 3.6 ft. / 1.1 m
Weight: 12 pounds / 5.5 kg
S. youngi was the first dinosaur discovered with primitive feathers. This turkey-sized dinosaur had very long legs and was a fast runner. It was a very intelligent dinosaur, as it had a relatively big brain. The largely complete skeleton and skull revealed for the first time the arm, back, and neck structure of the troodontids.

Troodontidae

Troodontids resemble early birds in the complex middle ear, associated sinuses and teeth constricted between the root and the crown; dromaeosaurids in their stiff tail and sickle-like toe; and ornithomimids ("ostrich dinosaurs") in the arrangement of their leg bones, elongated neck vertebrae, the general shape of the head and form of the braincase. They were the brainiest of all dinosaurs, with a brain size - and presumably intelligence - equal to that of modern birds. The eyes are huge and placed forward, meaning they had excellent binocular vision, and the legs are long and sturdy, like the legs of ostrich dinosaurs. There are no known troodontid feather impressions. However, as they were closely related to both dromaeosaurs and archaeopterygids, it is almost certain that they had similarly advanced feathers.



Mei long
Means: "Sleeping Dragon"
Pronounced: my long
Age: Early Cretaceous - 130 MYA
Place: Liaoning, China
This 2004 discovery was quickly dubbed "the sleeping dragon" because of its posture. Its forelimbs are folded bridle next to its body and its "tucked-in" head position is identical to that of birds. This is the first case of such behavior being shown in the fossil record.

Bambiraptor feinbergorum
Name Means: "Baby Raider"
Pronounced: Bam-bee-RAP-for
Bambiraptor is one of the most important fossils found in North America. This little bird-like dinosaur was a very quick runner, and it may have been an important step in dinosaurs' evolution into birds. Scientists believe that feathers and fuzz covered its body. The fuzz would have been like the downy covering on baby birds. Bambiraptor had quite a few features in common with modern birds. It had a wishbone, something all modern birds have that allow them to flap their wings, and its arms and hands were very long for its body size. In fact, the length of its arms and hands approached the lengths needed for flight.

Aves

The vertebrate class Aves includes the birds. An estimated 9,000 species exist worldwide. They have light yet strong hollow bones, a skeleton in which many bones are fused or lost, powerful flight muscles, and - most importantly - feathers. Today we know that not all dinosaurs became extinct. They survive in the form of the birds that fly around in your back yard.



Eoalulavis hovasi
125-130 MYA

Haliaeetus leucocephalus
Names Means: "White-headed sea eagle"
Pronounced: Age: Modern Day
Place: Native to North America
The Bald Eagle is the national bird of the United States. It is found throughout the country. It is a bird of prey and often lives near large bodies of water, where it catches fish. It is an excellent flyer, able to ride thermal convection currents, permitting it to travel great distances.

Bald Eagle Forelimb
Modern birds have small, lightweight bones, large wing surfaces and short tails. Large sternums (breast bones) allow for large flight muscles. These permit them to be excellent flyers.

Family Tree

The feathered dinosaurs show the evolutionary development of one bird-like feature after another - feathers, wings, special bones, behavior, etc. The big problem is the timing. These developments should have led to the first modern bird appearing about 60 million years ago, but yet Archaeopteryx lived 150 million years ago, long before any of the bird changes took place in dinosaurs.

NEW CHART TO BE PREPARED



Each of the feathered dinosaur families developed bird-like features in its own way. Thus there were many several different lines of evolution. Archaeopteryx was the result of another one. The big problem is no fossils have been found of its ancestors.

The Puzlement

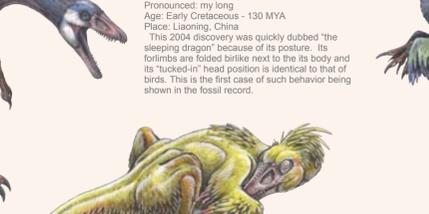
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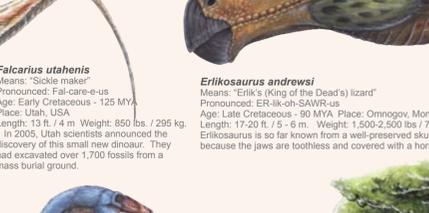
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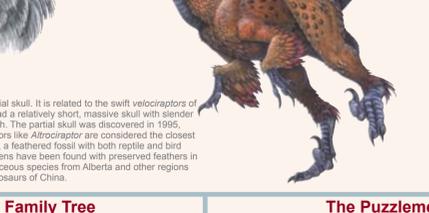
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